
Paspalum biaristatum (Poaceae: Paniceae), a New Serpentine Endemic from Goiás, Brazil, and the Second Awned Species in the Genus

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ABSTRACT. *Paspalum biaristatum*, a perennial species of subgenus *Ceresia*, is described, illustrated, and compared to its putative sister species, the annual *P. longiaristatum* Davidse & Filgueiras, as well as to other species in the subgenus. A new section, *Biaristata*, is described to accommodate the new species and *P. longiaristatum*.

During a field trip to Niquelândia in the Brazilian state of Goiás to re-collect material of the recently described *Paspalum longiaristatum* (Davidse & Filgueiras, 1993), much to our surprise, another unusual *Paspalum* L. with awned spikelets was discovered. It seems obviously related to *P. longiaristatum* but differs in a number of significant characters and is here described as a new species.

Paspalum biaristatum Filgueiras & Davidse, sp. nov. TYPE: Brazil. Goiás: Niquelândia, Macedo, ca. 14°18'S, 48°23'W, 18 km N de Niquelândia, cerca de 80 cm de altura, raque cor verde, 10 jun. 1992, T. S. Filgueiras 2341 (holotype, IBGE; isotypes, B, F, FLAS, ICN, ISC, K, MEXU, MO, P, R, RB, SI, SP, UB, US). Figure 1.

Paspalum longiaristatum Davidse & Filgueiras spiculis anguste elliptico-lanceolatis, gluma superiore aristata, lemma inferiori aristato, lodiculis nullis simile sed habitu perenni, culmis 73–125 cm altis, spiculis 3.8–4.5 mm longis, arista superioris glumae 4–7.1 mm longa et arista inferioris lemmatis 3.8–4.5 mm longa absimile.

Coarse, caespitose perennial. Rhizomes small, knotty, superficial. Culms 73–125 cm tall, semi-decumbent at the base, erect upward, unbranched or branched, with 6–9 elongated internodes; internodes hollow, stramineous, the lower ones scaberulous toward the apex, the upper ones smooth, glabrous; nodes dark, the lower ones glabrous to papillose-hirsute, the upper ones glabrous. Leaves mostly cauline; sheaths strongly striate, rounded on the back, the lower ones papillose-hirsute, becoming glabrescent to glabrous upward, the margins free,

one densely ciliate, the hairs 1–1.5 mm long, rarely both margins ciliate; ligule a minute ciliate membrane, the membrane 0.2–0.3 mm long, the cilia 1–1.2 mm long; blades 7.2–19.3 cm long, 1.2–5 mm wide, flat, linear, papillose-hirsute, the marginal hairs 1–2 mm long, slightly narrowed basally, abruptly acuminate apically, the midrib projected abaxially. Inflorescence of (1–)2–4(–7), racemosely arranged, unilateral racemes; peduncle included to well exerted, glabrous; common rachis 4–5.8 cm long, glabrous to papillose, with a tuft of hairs at the base of each internode and each raceme; racemes (1.7–)3–8(–13) cm long, arcuate, acuminate apically; raceme rachis extending beyond the spikelets to an acuminate sterile apex, prominently winged, the wings 4.5–7 mm wide, completely enclosing the spikelets, the central portion coriaceous, light green, the middle portion membranous, green or with purple spots, slightly striate, the outer portion hyaline, colorless, nerveless, the margins minutely denticulate-ciliolate. Spikelets solitary, alternately arranged on each side of the rachis, pedicelled; pedicel 0.3–0.5 mm long, scabrid. Spikelets 3.8–4.5 mm long, 0.4–0.5 mm wide, dorsally compressed, abaxial, disarticulating below the glumes and falling as a unit, narrowly elliptic-lanceolate in outline, pale, rarely purple, awned, with 2 florets; lower glume absent; upper glume 3.8–4.5 mm long, as long as the spikelet, awned, strongly 3-nerved, pale, rarely purplish, hyaline, narrowed at the base, slightly to prominently convex on the back in the lower $\frac{1}{4}$ – $\frac{1}{3}$, flat in the upper $\frac{1}{2}$, densely pubescent on the back in the lower $\frac{1}{4}$ – $\frac{1}{3}$, otherwise glabrous, the margins densely pectinate-ciliate with hairs 1.7–2.2 mm long, the awn 4–7.1 mm long, minutely antrorsely scaberulous, flexuous, not geniculate; lower floret sterile, consisting only of an awned, lower lemma 3.8–4.5 mm long, pale, rarely purplish, hyaline, densely pubescent on the back in the lower $\frac{1}{4}$ – $\frac{1}{3}$, otherwise glabrous on the back, the margins densely pectinate-ciliate with cilia 1.7–2.2 mm long, the awn 3.8–4.5 mm long, minutely antrorsely scaberulous, flex-

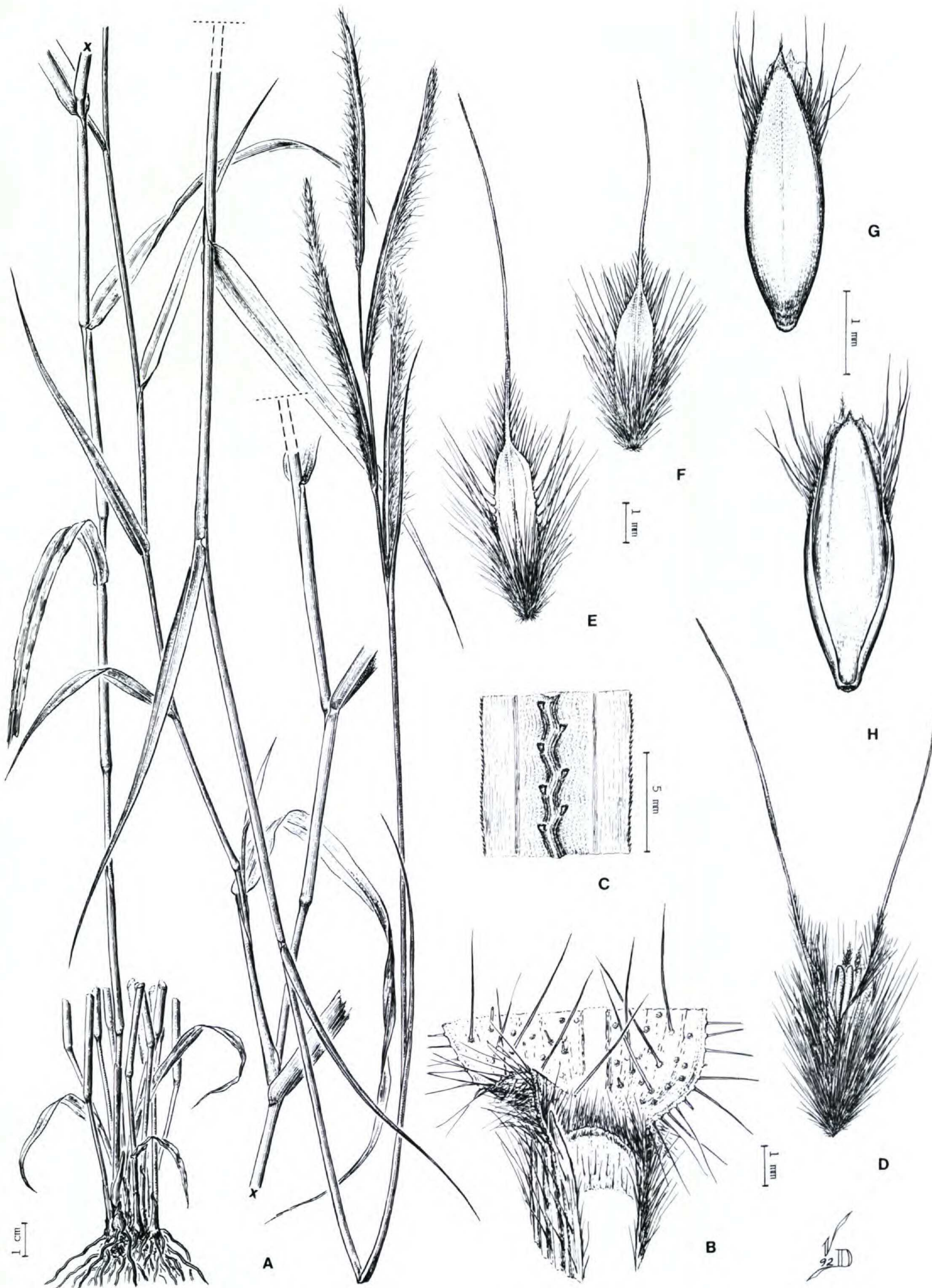


Figure 1. *Paspalum biaristatum* Filgueiras & Davidse. —A. Habit. —B. Ligular area of the leaf. —C. Portion of the winged rachis with the spikelets removed, showing the minute pedicel bases. —D. Spikelet at the beginning of anthesis. —E. Upper glume. —F. Lower lemma. —G. Upper floret, lemma side. —H. Upper floret, palea side. (Based on Filgueiras 2341.)

TABLE 1. Leaf blade size (length (cm) \times width (mm)), inflorescence length (cm), and uppermost raceme length (cm), with their ratios, of 60 culms of *Paspalum biaristatum*.

	Leaf blade	Leaf L/W	Inflorescence	Uppermost raceme	Inflorescence L/raceme L
Maximum	16.6 \times 5.0	8.0	19.3	12.5	2.17
Minimum	7.2 \times 1.2	1.78	4.1	2.3	1.1
Average	10.8 \times 2.7	4.49	10.2	6.3	1.65
SD	2.0 \times 1.14	1.70	3.0	2.24	0.26
Variance	4.29 \times 1.31	2.79	9.04	5.04	0.07

uous, not geniculate; lower palea absent; upper floret 3.5–3.7 mm long, bisexual, slightly coriaceous, pale, rarely purplish or pale and purplish; upper lemma 3.3–3.5 mm long, obscurely 5-nerved, acute, glabrous to ciliate on the upper $\frac{1}{3}$, the cilia few to many in a tuft on each side, 0.5–1.2 mm long, the apex minutely papillate to conspicuously ciliate; upper palea 3.2–3.4 mm long, glabrous, papillose at the apex, rarely smooth; lodicules absent; stamens 3, terminally exerted; anthers 2–2.2 mm long, yellow, rarely purple; ovary 0.4–0.5 mm long, glabrous; styles 2, separate; stigmas plumose, yellow or purple; caryopsis 1.2–1.5 mm long, 0.3–0.5 mm wide; embryo $\frac{4}{10}$ – $\frac{5}{10}$ as long as the caryopsis; hilum punctate, basal, $\frac{2}{10}$ – $\frac{3}{10}$ as long as the caryopsis.

Paratypes. BRAZIL. **Goiás**: Niquelândia, Macedo, ca. 18 km N de Niquelândia, campo, 3 ago. 1992, T. S. Filgueiras & R. D. Lopes 2408, 2409 (IBGE, MO, NY, SI, SP, UFG); same locality, 19 maio 1993, T. S. Filgueiras & F. C. de A. Oliveira 2450 (CTES, F, G, IBGE, ISC, MO, NY), 2458 (LBP, VEN).

A remarkable degree of variation was observed in this species in such easily visible characters as leaf and raceme size, as well as degree of culm branching. On the basis of ordinary visual comparison, one collection, *Filgueiras & Oliveira 2450*, seemed to differ dramatically from the others in its relatively shorter and narrower leaf blades and racemes, as well as its more profuse branching. This was so conspicuous that we initially had serious doubts that it could be included in the circumscription of this new species. To investigate this variation more thoroughly, we made the following measurements from 60 culms taken from 32 plants of all the gatherings: length and width of the fourth blade below the lowermost raceme, inflorescence length, and the length of the uppermost raceme. The data thus obtained (Table 1) revealed that the variation in these characters is actually continuous among the known gatherings, although the *Filgueiras & Oliveira 2450* gathering occupies the low end of the range of variation and has more branches per culm than the other gatherings.

The occurrence of cilia on the upper lemma is also unusually irregular. The great majority of the spikelets examined showed no cilia on the upper portion of the lemma. However, a small number had as few as 2 to as many as 20 and then formed a tuft of hairs on each side (Fig. 1G, H). Although it is not unusual to observe considerable variation in the amount of pubescence in the lower spikelet bracts of *Paspalum* species, we have never observed much variation in the few species of *Paspalum* [*P. ceresia* (Kuntze) Chase, *P. carinatum* Kunth, *P. heterotrichon* Trinius, *P. hitchcockii* Chase, *P. trachycoleon* Steudel, *P. macroblepharum* Hackel] that have pubescent or puberulent upper lemmas.

The color of the spikelet parts (upper glume, lower lemma, and antherium) was also found to vary considerably, from pale to purplish to deep purple. A few bicolored (pale and purple) upper florets were also observed.

That awned spikelets are very unusual in the genus has already been discussed (Davidse & Filgueiras, 1993). There seems little doubt that *Paspalum biaristatum* and *P. longiaristatum* are sister species because they share the following characters: 2-awned spikelets, similarly shaped, narrow spikelets, particularly a similar upper glume and lower lemma, texture of upper floret, lack of lodicules, and morphologically similar, racemosely arrayed, winged racemes. These characters firmly place these species in subgenus *Ceresia* (Persoon) Reichenbach (Davidse & Filgueiras, 1993), where they form a distinct group characterized by their 2-awned, narrow spikelets. As these features cannot be found elsewhere in the genus, we here propose a new section of subgenus *Ceresia* to accommodate these two species.

Paspalum* sect. *Biaristata Filgueiras & Davidse, sect. nov. TYPE: *Paspalum biaristatum* Filgueiras & Davidse.

Plantae annuae vel perennes. Rhachis alata, membranacea. Spiculae solitariae, angustae; gluma superior aristata; lemma inferius aristatum. Lodiculae nullae.

TABLE 2. Main distinguishing features of *Paspalum biaristatum* and *P. longiaristatum*.

Character	<i>Paspalum biaristatum</i>	<i>Paspalum longiaristatum</i>
Habit	perennial	annual
Culms (cm)	73–125	15–36
Blades (cm × mm)	7.2–19.3 × 1.2–5	4–8.2 × 1–2
Racemes (cm)	1.7–13	2–6.8
Spikelets (mm)	3.8–4.5	1.8–2.2
Awn of upper glume (mm)	4–7.1	6–12.2
Awn of lower lemma (mm)	3.8–4.5	0.3–2

Paspalum biaristatum and *P. longiaristatum* are at once easily distinguished by their different stature, life forms, and the other characters summarized in Table 2. Although both species have awned spikelets, the actual and relative size of the spikelets and awns is significantly different: *P. biaristatum* has relatively large spikelets with a relatively smaller awn on the upper glume and a larger awn on the lower lemma, whereas *P. longiaristatum* has smaller spikelets with a longer awn on the upper glume and a much smaller awn on the lower lemma.

Primarily because of its more specialized annual habit, the only occurrence in the subgenus, *P. longiaristatum* is a more specialized species and probably has been derived from *P. biaristatum* or a common ancestor of the two species. The narrow-leaved, more highly branched form as represented by Filgueiras & Oliveira 2450 varies in the direction of *P. longiaristatum*. As one way to explain this variation, we hypothesize that occasional or even rare hybridization with backcrossing of the hybrid to *P. biaristatum* may occur. This could account for the appearance of these vegetative characters (relatively narrow leaves, high branching) in plants that otherwise look like *P. biaristatum*. This also assumes at least some fertility in the hybrid. Both hypotheses are testable in an experimental garden, and we hope to be able to do this in the future.

Besides *P. longiaristatum*, the closest relationship of *P. biaristatum* to other species seems to lie with those species of subgenus *Ceresia* that have primarily cauline leaves, racemously arranged racemes, and nerveless, membranous rachis wings. Among these, *P. heterotrichon* is perhaps most similar to *P. biaristatum*. However, besides its awnless spikelets, *P. heterotrichon* differs in its generally shorter and narrower leaf blades, generally more elongated culm internodes, shorter racemes, slightly broader spikelets, nearly glabrous lower lemma that is slightly sulcate on each side of the midnerve, and well-developed lodicules. *Paspalum heterotrichon* has a wide distribution including Panama, Colombia, Venezuela, Peru, Brazil, and Hispaniola. We hy-

pothesize that a species such as *P. heterotrichon* or its progenitor, which occurred on nonserpentine savanna soils, is likely to be the ancestor of the awned species. We, therefore, consider it most likely that the two awned species are recently derived or neoen- demic (sensu Brooks, 1987) taxa.

Paspalum biaristatum was found growing in size- able populations on serpentine soil in an area of approximately 1 km², side by side with *P. longiaristatum*. Both species are narrow endemics because their populations are restricted to only a few square meters wherever they occur. Although the Niquel- ândia complex is quite large, 59 km long and 29 km wide (Berbent et al., 1981), the ultramafic rocks themselves are restricted to a west-dipping zone 2– 4 km wide (Brooks et al., 1990). Therefore, though these species may eventually be found in similar habitats along the ultramafic rock belt of central Brazil, the total area of suitable habitat is very small.

The Macedo site in Niquelândia is the center of Brazil's largest nickel mining and smelting operation (Brooks et al., 1990). In fact, at the time the second collection of *P. biaristatum* was being made (August 1992), the collectors could distinctly hear the noise from the tractors working on the nickel mines some 300 m away. It therefore seems that because of their localized occurrence in habitats subject to a great deal of disturbance, both species should be considered to be in imminent danger of extinction.

The descriptive epithet *biaristatum* refers to the characteristic 2-awned spikelets of this species.

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